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ORIGINAL RESEARCH

Polypropylene suture material with anti-inflammatory action

Mikhail Razumov[1] · Olga Gornukhina[1] · Oleg Golubchikov[1] · Irina Vershinina[2] · Artur Vashurin[1,3]

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Abstract
Polypropylene (PP) monofilament threads are widely used as surging sutures. Functionalization of their surface to impart new properties is of great importance and interest for medicine. This work provides an efficient approach for chemical activation of PP surface followed by anchoring of anti-inflammatory materials (aspirin and indomethacin). Two chemical routes for activation of PP surface and two anti-inflammatory substances were combined, giving a set of four different functionalized threads. Efficiency in terms of anti-inflammatory action of resultant hybrid materials was proved by ligation of wounds made along the spine of mice with further monitoring of inflammation process. In vivo test on mice showed the best healing of surgical skin wounds by means of suture activated by 45% H_2O_2 solution in the presence of $FeSO_4$ as catalyst at 60 °C for 2 h, which was then modified with aspirin. Plasma interleukin measurement and histological section experiment were performed to prove the efficiency of the threads used for tissue connection. Highest healing efficiency of the suture is obviously explained by higher containment of anti-inflammatory substance anchored on PP surface. The work provides data on a cheap and easy implementation method for novel hybrid materials in medical applications that are able to perform accurately on surgical intervention sites.

Keywords Polypropylene monofilament thread · Functionalization · Anti-inflammatory · Aspirin · Indomethacin

Introduction

The most widely used approach for tissue connection is by means of surgical suture [1]. The generally accepted characteristics of an ideal suture material contain superior tensile strength, sufficient knot reliability, excellent handling characteristics, minimal tissue reaction, absence of allergenic properties, resistance to infection, and eventual absorption when tissue repair has reached satisfactory levels. Except in a very few situations where permanent sutures are a necessity, such as anastomoses between prosthetic and host blood vessels, a satisfactory absorbable material would be desirable [2, 3]. An initial idea of surgery suture modification belongs to ab Aquapendente from Padua. He decided to use "flax imbued with gum". Lister suggested covering catgut with chrome to make it tougher [4]. Modification of surgery suture to impart new properties had been widely expanded further. At present, suture has been modified using various methods. Principally, polyfilament threads are being modified to improve biological properties and remove "sawing effect". Monofilament materials have certain advantages including weak traumatic effect upon pulling due to smooth surface of monofiber, high durability of the thread in tissues (PDS loses only 30% in the first month) [5, 6], and high bioinertness. There is almost no reaction of tissue toward polyolefins and thus they are used for infected tissues [4]; among them, polypropylene has a reliable knot (minimal number is four) [1, 4].

Functionalization of sutures is of great importance because it allows regulating threads' properties finely depending on the aim of surgical intervention. However, for the first time, activation of the material surface is needed for further anchoring of the active compound. There are different ways to realize it, e.g., by radiation [7], plasma assistance [8–10], chemical way [11–13], and mechanistic

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✉ Mikhail Razumov
MandL@bk.ru

[1] Ivanovo State University of Chemistry and Technology, 153000 Ivanovo, Russia

[2] G. A. Krestov Institute of Solution Chemistry of RAS, 153045 Ivanovo, Russia

[3] Kazan Federal University, 420008 Kazan, Russia